June 1998 Highlights of the Pulsed Power Inertial Confinement Fusion Program

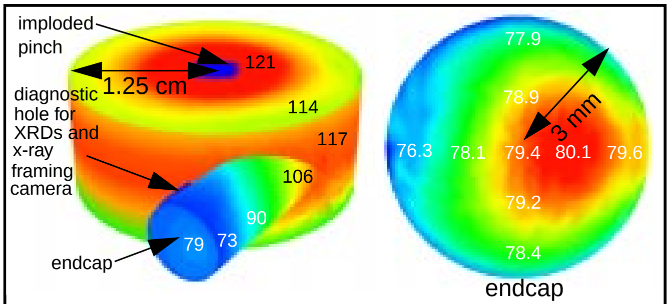

Fig. 1. Flux distribution in primary and secondary hohlraums for Shots 189-190 in February from Lightscape (left). Temperatures in eV are for 90 TW pinch power. At right is calculated flux on endcap as viewed by shock diagnostics.

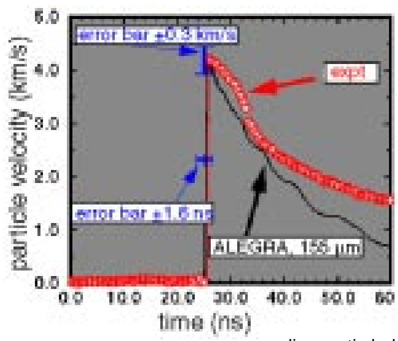

Fig. 2. Experimental and simulated velocity profiles from Shot 190. Note sharp rise of shock and minimal radiation prepulse. Interface between Al sample and LiF window on endcap is at 155 µm depth.

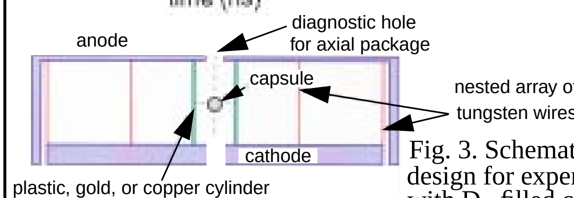

Fig. 3. Schematic of design for experiment with D_2-filled capsule.

This month we authored or coauthored 45 presentations at the 12th Intl. Conf. on High Power Particle Beams, the 25th IEEE Intl. Conf. on Plasma Science, and the 12th Topical Conf. on High-Temperature Plasma Diagnostics. The 17 Z shots were two dynamic hohlraum ones with a plastic ablator at the end of an on-axis secondary, four with secondaries driven by a primary vacuum hohlraum for equation of state (EOS) studies, four LLNL hohlraum shots to view the plume from an imploding pinch through a ring with 17 radial Be wires glued at 20 degree increments, three static-walled ICF hohlraum shots to evaluate hole closure, one to measure current near the load with a Bdot monitor, and three LANL weapons physics shots.

On Shots 189-190 active shock breakout diagnostics at the end of an off-axis secondary measured the nonuniformity of the radiation field driving an EOS sample. Ideally, the temperature gradient across the endcap, where the sample is located, should be small and the resultant shock wave sufficiently planar that 2D and edge effects are negligible. We are using the 3D radiosity code Lightscape™ to explain why the endcap temperature is nonuniform (Fig. 1) and to find geometries that increase the uniformity. The code predicts a maximum lateral gradient of 1.6 eV/mm for a radiated pinch power of 90 TW. This temperature nonuniformity is caused by 3D geometric effects of emission from the secondary walls and of the flux into the secondary as a result of wall emission from the vacuum primary. The vertical gradient is weaker (0.5-0.75 eV/mm) with an up-down asymmetry because of the more direct view of the anode-cathode gap. The code also predicts an axial gradient along the secondary of 4.2 eV/mm, which can be compared with x-ray framing camera images on EOS shots taken this month. We also compared velocity interferometer data with 1D results from the radiation-hydrodynamics package being developed for the ALEGRA code. Using a radiation drive history from x-ray diodes (XRDs) that view the hohlraum wall through a 4-mm-diameter hole, the package predicts shock pressures and particle speeds slightly lower than measured (Fig. 2) and no radiation preheat at the Al/LiF interface.

If 5-keV to 1-MeV electrons preheat an ICF capsule and fuel, compressing the fuel to fusion conditions will require more energy and hence a larger z-pinch driver for high yield than if the fuel were cold. We have inferred the >60-keV electron spectrum on Z and Saturn from time-integrated thermoluminescent detectors and the source location from bremsstrahlung images but need improved diagnostics to determine the contribution by low-energy electrons and photons. Earlier Z experiments suggested significant electron acceleration to the anode (see identifiable anode image in Nov. 1997 Highlights). However, measurements on Shots 243-248 indicate the high-energy electron flux can be reduced and perhaps controlled by changes in electrode design. Fuel heating by >60 keV electrons on Z is estimated as small (~0.2 eV). For X-1, the reduction in fuel preheat by target and electrode design will be examined.

A capsule filled with doped or undoped D_2 and embedded in a dynamic hohlraum is being designed with LASNEX for Z experiments in the fall (Fig. 3). These first experiments will provide the basis for X-1 dynamic hohlraum high-yield designs. Diagnostics will include neutron time of flight, neutron activation, and time-resolved x-ray imaging.

Contact: Jeff Quintenz, Inertial Confinement Fusion Program, Dept. 9502, 505-845-7245, fax: 505-845-7464, email: jpquint@sandia.gov.
Highlights are prepared by Mary Ann Sweeney, Dept. 9502, 505-845-7307, fax: 505-845-7890, email: masween@sandia.gov.
Archived copies of the *Highlights* beginning July 1993 are available at http://www.sandia.gov/pulspowr/hedicf/highlights.